



doi • 10.5578/tt.68188  
Tuberk Toraks 2019;67(1):55-62  
Geliş Tarihi/Received: 24.01.2019 • Kabul Ediliş Tarihi/Accepted: 31.03.2019

KLİNİK ÇALIŞMA  
RESEARCH ARTICLE

# Our eight years experience in postintubation/ posttracheostomy tracheal stenosis

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**Cite this article as:** Özgül MA, Gül Ş, Çetinkaya E, Turan D, Kırkil G, Chousein Uğur EG, et al. Our eight years experience in postintubation/posttracheostomy tracheal stenosis. 2019;67(1):55-62.

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## SUMMARY

### Our eight years experience in postintubation/posttracheostomy tracheal stenosis

**Introduction:** The most common cause of tracheal stenosis (TS) continues to be traumas according to the intubation and tracheostomy. Bronchoscopy is considered the gold standard for the detection and diagnosis of tracheobronchial pathology. There are several treatment options. We aimed to discuss our tracheal stenosis patients' treatment options, and their follow-up period.

**Materials and Methods:** Consecutive referred patients between 2009 and 2018 presenting with TS were reviewed for the study. Demographic characteristics, localization, length and degree of stenosis, treatment techniques, postoperative complications, and survival were recorded for all patients.

**Results:** A total of 110 patients included. The mean age was  $53.7 \pm 16.7$  (16-98 years) years. Of 110 patients, 54 (49.1%) were female. Most common type of stenosis was complex stenosis (74.5%). Mechanical dilatation was applied to all patients. Stenotic regions of 22 (20%) patients were cut with bronchoscopic scissor. Tracheal stents were inserted into trachea of 49 (44.5%) patients. During follow-up period; 36 of 110 (32.7%) patients had surgical resection. Six of 36 (16.7%) patients died during follow-up period (one of them died during surgery), 17 (47.2%) patients had total recovery after surgery. Thirteen of 36 (36.1%) patients had restenosis after surgery.

**Conclusion:** Tracheal stenosis is a process seen after postintubation or posttracheostomy frequently and it has a wide range of management modalities. Although, it is believed that surgery is the most efficient technique in cases without medical contraindications, we determined that endoscopic interventions can be alternative therapeutic options for inoperable patients. Patients must be followed-up after interventional therapies because complications, and restenosis can usually be seen.

**Key words:** Postintubation tracheal stenosis; posttracheostomy tracheal stenosis; treatment

## ÖZET

### Postentübasyon/posttrakeostomi trakeal stenozlarda 8 yıllık tecrübemiz

**Giriş:** Travmaya bağlı trakeal stenozun en sık nedeni postentübasyon/posttrakeostomi trakeal stenozlardır. Trakeobronşiyal patolojilerin tespitinde ve tedavisinde bronkoskopi altın standarttır. Trakeal stenoz tedavisinde pek çok seçenek olup, trakeal stenozlu hastalarımızın tedavi opsiyonlarını ve takiplerini tartışmak istedik.

**Materyal ve Metod:** 2009-2018 yılları arasında trakeal stenoz nedeniyle bize refere edilmiş hastalarımız çalışma için değerlendirildi. Hastaların tüm demografik verileri, stenozun lokalizasyonu, uzunluğu, derecesi, tedavi teknikleri, postoperatif komplikasyonlar ve sürvileri kaydedilmiştir.

**Bulgular:** Toplam 110 hasta çalışmaya alındı. Ortalama yaş  $53.7 \pm 16.7$  (16-98 yıl) idi. Yüz on hastanın 54 (%49.1)'ü kadındı. En sık rastlanan darlık tipi, kompleks tipte trakeal stenozdu (%74.5). Hastaların hepsine mekanik dilatasyon uygulanmıştı. Yirmi iki (%20) hastanın darlık alanı makasla kesilmişti. Kırk dokuz (%44.5) hastaya trakeal stent yerleştirilmişti. Takiplerde 110 hastanın 36 (%32.7)'sına göğüs cerrahisince trakeal rezeksiyon uygulandı. Cerrahi geçiren 36 hastanın 6 (%16.7)'si takiplerde yaşamını kaybetti (1 hasta cerrahi sırasında kaybedildi). On yedi (%47.2) hasta cerrahi sonrası tamamen iyileşti. On üç (%36.1) hastada cerrahi sonrası restenoz gelişti.

**Sonuç:** Trakeal stenoz sıklıkla entübasyon ya da trakeostomi sonrası ortaya çıkan bir durumdur ve çeşitli tedavide modaliteleri vardır. Kontrendike olmadığı durumlarda, cerrahi tedavi, uygun olgularda daha etkili kabul edilmektedir. Cerrahinin kontrendike olduğu durumlarda endoskopik girişimler cerrahiye alternatif olarak önerilebilir. Girişimsel işlemler sonrası hastalar komplikasyon ve restenoz gelişebileceğinden takip edilmelidir.

**Anahtar kelimeler:** Postentübasyon trakeal stenoz; posttrakeostomi trakeal stenoz; tedavi

## INTRODUCTION

Laryngotracheal stenosis (LTS) is a rare condition, which causes significant morbidity and can precipitate lifethreatening airway compromise. It can be caused by a variable pathologic processes, the most common being postintubation injury (1). Postintubation tracheal stenosis (PITS) is occurs mainly after tracheostomy or longterm intubation. While granulation tissue formation due to intubation could occur within hours, tracheal stenosis usually takes more than five days to appear (2). Intensive health care administrations has decreased its incidence over years. The reported incidence of tracheal stenosis after tracheostomy and prolonged intubation varies between 0.6% to 21% and 6% to 21%, respectively (3,4). In a study performed in London, the predictive rate of PITS was calculated as 926 new cases per one year. The incidence may differ in various countries. The high incidence could be seen in the countries with high ICU bed occupancy and large population at risk.

The stenosis generally develops as a result of ischemic necrosis in the trachea secondary to the endo-

tracheal tube overinflation or to the tracheostomy cuff. While same mechanism of action can cause posttracheostomy tracheal stenosis (PTTS); destruction of cartilaginous support after tracheal ring fractures during tracheostomy placement may result in more complex ones.

Regarding the risk factors of PITS, some studies have demonstrated prolonged intubation (more than 24 hours), endotracheal tube material, over-inflation of its cuff, trauma during intubation and tube displacement after intubation (4).

Unfortunately, because of the severity of symptoms, most of these patients undergo tracheostomy despite the fact that the main treatments for these patients are bronchoscopy and dilatation as well as airway resection and reconstruction at an appropriate time. Although there is various therapeutic options, end-to-end anastomosis following tracheal resection is the treatment of choice for PITS.

In this study, we aimed to present our data of PITS/PTTS developed cases and their management strategy according to the current literature. All data regarding

their etiology, treatment choice, recurrence, and mortality are also discussed.

## MATERIALS and METHODS

After the approval of the Local Ethics Committee, all consecutive referred patients with TS between January 2009 and December 2018 were retrospectively reviewed. Among them patients that have PITS/PTTS were recruited to the study. Patients who had tracheal stenosis due to the causes other than postintubation/posttracheostomy and patients who had missing data were excluded from the study. Demographic characteristics, localization of the stenosis, stenosis length and degree, treatment techniques, post-procedural complications, and survival were recorded for all patients. The stenosis type was defined as complex, web-like, or mix. Degree of stenosis is classified into 3 groups: 1) mild stenosis (i.e.  $\leq 50\%$  reduction in the cross-sectional area (CSA), 2) moderate stenosis (51%-70% obstruction), 3) severe stenosis ( $\leq 71\%$  reduction in CSA) (5). The combination of interventions employed included mechanical dilatation, mechanical resection, cryo, argon plasma coagulation (APC), topical mitomycin-C application, bronchoscopic scissor and stent insertion.

All bronchoscopic procedures were performed either conscious sedation or IV-total anesthesia at the Division of Interventional Pulmonology of our hospital. While local anesthesia were used for flexible bronchoscopic procedures, IV-total anesthesia were used for rigid bronchoscopy. BF-1TQ180 or BF-XP160 (Olympus Medical Systems, Japan) with a 2.8 mm working channel were used for flexible procedures and Karl Storz, Germany for rigid ones. Conscious sedation is started with 2-5 mg midazolam and later on 10% lidocain spray/gel was used for local anesthesia. During the procedure spray-as-you-go technique was applied with 1% lidocain solution. All patients were supported by either nasal or oral administration of oxygen and routine monitoring with pulse oximetry was done. IV-total anesthesia was achieved with 0.05-0.1 mg/kg midazolam, a maximum of 1 g propofol, a maximum of 2 mg remifentanyl, and a maximum of 50 mg rocuronium.

## RESULTS

A total of 110 patients between 2009 September-2018 February were identified who had tracheal stenosis.

The mean age at time of entry into the study was  $53.7 \pm 16.7$  (16-98 years) years. Of 110 patients, 54 (49.1%) were female. Most common comorbidity was hypertension while 17 patients had no comorbidity (Table 1).

While trauma was the most seen cause of tracheal intubation ( $n= 20, 18.1\%$ ), others were surgery ( $n= 10, 9.1\%$ ), or any kind of medical illness (Table 2).

Twenty-nine (26.4%) patients had posttracheostomy stenosis, 81 of them (73.6%) had postintubation stenosis. Mean follow up period for all patients was  $44.9 \pm 32.3$  month (range, 2-108 month).

**Table 1.** Demographics of 110 patients

Age (years)	53.7 $\pm$ 16.7
Sex (M/F)	56/54
Comorbidity	
Hypertension	34 (30.9%)
Diabetes mellitus	27 (24.5%)
Coronary artery disease	19 (17.3%)
COPD	17 (15.4%)
Ischemic heart disease	16 (14.5%)
Malignancy	10 (9.1%)
Congestive heart failure	8 (7.3%)
Epilepsy	6 (5.4%)
Cerebrovascular disease	5 (4.5%)
Chronic renal failure	4 (3.6%)
Others (MI, hypothyroidism, cirrhosis, Parkinson, pulmonary embolism, aritmia)	13 (11.8%)
COPD: Chronic obstructive pulmonary disease, MI: Myocardial infarction.	

**Table 2.** Conditions leading to intubation

Condition	Number (%)
Trauma	20 (18.1%)
Respiratory failure	19 (17.3%)
MI	16 (14.5%)
Surgery	10 (9.1%)
Cerebrovascular disease	7 (6.4%)
Pneumonia	5 (4.5%)
COPD	5 (4.5%)
Epilepsy	3 (2.7%)
Acute renal failure	1 (0.9%)
Pulmonary hemorrhage	1 (0.9%)
COPD: Chronic obstructive pulmonary disease, MI: Myocardial infarction.	

**Table 3.** Some characteristics of stenosis, therapy methods, and mortality rate of patients

Mean distance from stenosis to vocal cord	2.7 ± 0.8 cm
Mean length of stenosis	2.1 ± 1.0 cm
Therapy methods	
Mechanical dilatation	109 (99.09%)
Cut with bronchoscopic scissors	22 (20%)
Cryotherapy	20 (18.2%)
APC application	5 (4.5%)
Topical mitomycin-C	6 (5.4%)
Tracheal stent insertion	49 (44.5%)
Mortality	
Patients without surgery	27 (24.54%)
Patients with surgery	6 (5.4%)

Most common type of stenosis was complex stenosis that occurred in 82 (74.5%) patients, web-like stenosis was observed in 15 (13.63%), mix stenosis was observed in 13 (11.81%) patients. The mean length of stenosis was 2.1 ± 1.0 cm (range, 1-6 cm). Mean distance from stenosis to vocal cord was 2.7 ± 0.8 cm (Table 3). Mean percentage of stenosis was 75.2 ± 15.2% (30-95%); 67 (60.9%) of them was severe stenosis, 31 (28.2%) of them was moderate stenosis, and 12 (10.9%) of them was mild stenosis.

All patients but one had mechanical dilatation as a therapeutic option. The median number of rigid bronchoscopy applied to all patients was 5 (min-max, 1-19). Mechanical dilatation, APC, cryotherapy, and topical mitomycin-C application were therapeutic options for patients with web-like stenosis, mechanical dilatation, cryotherapy, and bronchoscopic scissor were therapeutic options for patients with complex, and mix stenosis. Cut with bronchoscopic scissor applied to 22 (20%) patients, 20 (18.2%) patients had cryotherapy, and 5 (4.5%) had APC application. We applied topical mitomycin-C to 6 (5.4%) of 110 patients. Tracheal stent insertion applied to 49 (44.5%) patients (Table 3). The most preferred stents were silicone stenotic stents (especially size 16 x 14 x 16, and also 14 x 12 x 14, 15 x 13 x 15, 18 x 16 x 18). Apart from the silicone stenotic stents, silicone Y stents were also used (sizes 15 x 12 x 12 and 16 x 13 x 13). Stent type and dimensions were selected according to the width of the trachea and the length of the stenosis. Stent complication

after insertion was seen in 22 patients, these were; migration (n= 9, 8.2%), granulation (n= 16, 14.5%), malacia (n= 5, 4.5%), mucostasis (n= 18, 16.4%), and stenosis at the edge of the stent (n= 1, 1%). Earliest date for complication was 5<sup>th</sup> day, and the latest date was 24<sup>th</sup> month. Stent removed from 6 patients, and changed in 5 patients after complication occurrence.

After follow-up period; 13 of 74 patients (patients who were not applied surgery) (17.6%) were still alive with their stents, 29 (39.2%) of them cured without stent, 4 (5.4%) had tracheostomy, 1 (1.3%) had T-tube application, and 27 (36.5%) of them died (19 of them had tracheal stent) (Table 3) (Figure 1).

During follow-up period; 36 of 110 (32.7%) patients had surgical resection. Duration between surgery and first admission was 172.2 ± 442.4 (1-2007) days. Length of the resection tissue was 3.3 ± 1.3 (1.7-6.2) cm. Pathological examination of resected tissue revealed tracheobronchopathia osteochondroplastica in 3 patients, others had fibrosis, chronic nonspecific inflammation, calcification, and partly ulceration. Six of 36 (16.7%) patients died during follow-up period (one of them died during surgery), duration till death was 126.0 ± 178.3 days (range, 0-480 days). Seventeen (47.2%) patients get well after surgery. Thirteen of 36 (36.1%) patients had restenosis after surgery. Time for restenosis occurrence was 58.4 ± 56.0 (7-180) days. Most seen stenosis type was complex (n= 8) in these patients. Mean length of stenosis was 2 ± 0.9 cm, and percentage of stenosis was 62.9 ± 18.0. Of 12 patients with restenosis; 5 had tracheal stent insertion, 7 had mechanical dilatation, and 2 had cryotherapy (1 patient had both cryotherapy, and mechanical dilatation, 1 patient had both tracheal stent insertion, and mechanical dilatation) (Figure 1).

## DISCUSSION

In this study, we evaluated the data of 110 patients with tracheal stenosis. We observed that the most seen cause of tracheal intubation was trauma (n= 20, 18.1%), and most common type of stenosis was complex stenosis that occurred in 82 (74.5%) patients. The most applied therapeutic option was mechanical dilatation, other therapeutic modalities were; cut with scissors, cryotherapy, APC application, topical mitomycin-C, and tracheal stent insertion. During fol-

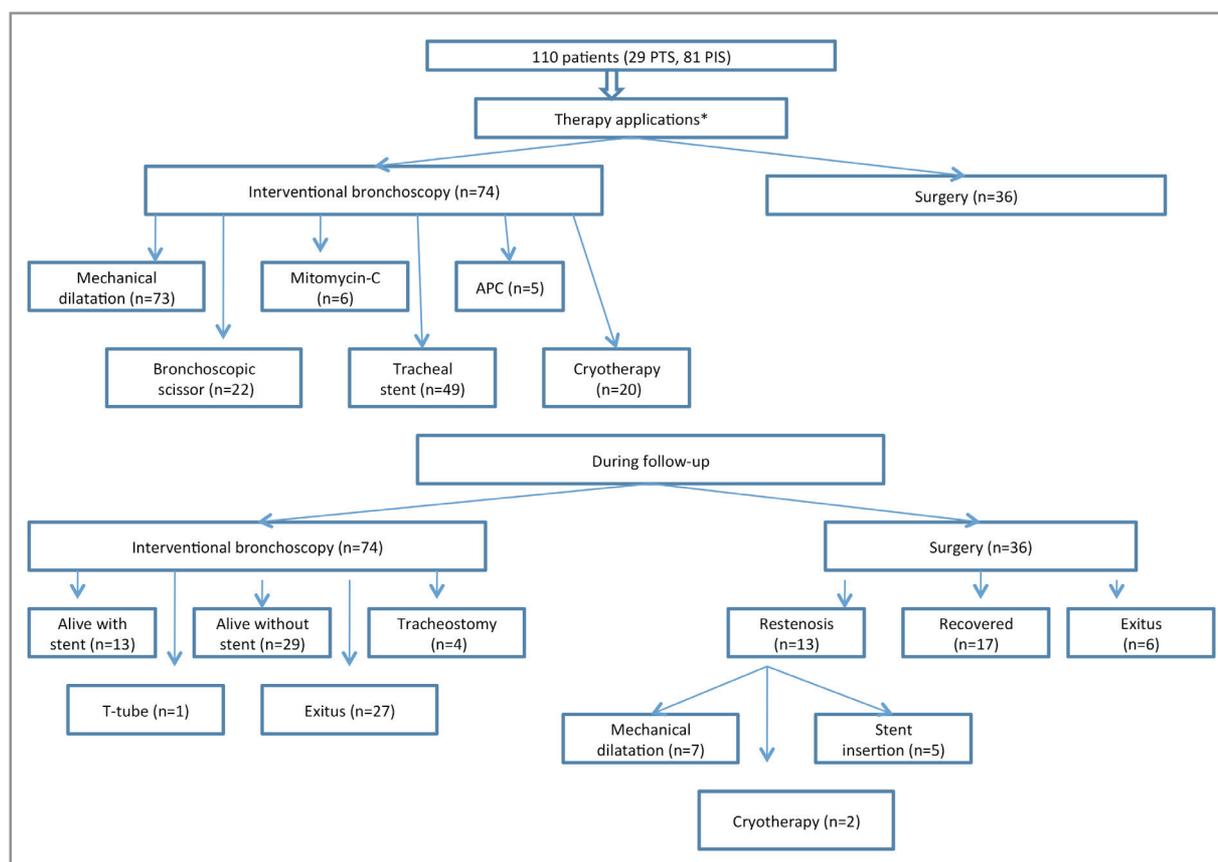


Figure 1. Schema of the patients therapeutic approaches.

low-up period; 36 of 110 (32.7%) patients had surgical resection, and 6 of 36 patients (16.7%) died, and 27 of 74 (36.5%) patients with no surgery died. So we conclude that, although clinical improvements were seen in many of the patients during their follow-up, PITS has a high mortality rate (30%) despite therapy.

One classification of tracheal stenosis was simple and complex. Simple ones are defined as the ones that are associated with a stenotic segment less than 1 cm in length with no associated tracheomalacia or loss of cartilaginous support (6). Most common type of stenosis in our patients was complex stenosis that occurred in 82 patients (74.5%).

The most diagnostic tools for PITS are rigid and flexible bronchoscopy. The gold standart approach for PITS assessment and management is rigid bronchoscopy. Additionally, rigid bronchoscopy gives the chance of emergency dilatation and maintaining airway patency to the interventional bronchoscopist. Careful evaluation to determine the length and grade of stenosis and

the peritracheal anatomic relationship is important. To assess these conditions flexible bronchoscopy is the preferred technique. Rigid with/without flexible fiberoptic bronchoscopy was performed to all of our cases.

The gold standard of PITS treatment is surgical reconstruction (7). While there is no consencus for the ideal time of surgical treatment, some investigators recommend to perform when endoscopic procedures fail following one or several attempts (8,9). In our study, 36 of 110 patients had surgery, of these patients 19 had only 1 endoscopic attempt, other had more than one endoscopic procedures.

The outcomes of surgery were reported as good or satisfactory results in 93.7% of patients, failure in 3.9%, and a mortality rate of 2.4% (10). In another study, the surgical success rate was as low as 61.5% George et al. reported 100 % success rate with surgery in their series of 26 adult patients with LTS (11,12). While mean resection length was 3.4 cm in their series, they also concluded that maximum 6 cm

resection length was also feasible. Marulli et al. reported 28 LTS patients treated with anastomosis following surgical resection (13). Mean resection length was 2.5 cm (ranging between 1.5 to 5.1 cm). In our study the mean resection length was  $3.3 \pm 1.3$  (ranging between 1.7-6.2) cm. Our success rate (47.2%) was lower than the reported literatures. It may be due to our institution experience or our patients characteristics, they were older (their mean age was 48.05), in Abbasidezfouli' study mean age was 23.9 (11).

Endoscopic procedures are accepted as alternative therapy to surgery, before twenty years it was shown that, silicone tracheobronchial stents were effective in the maintenance of airway patency and were associated with good tolerance (14). In their study, Zias et al. stated that patients with comorbidities and poor performance status might not be eligible for surgery (15). In the same study they reported that 95% of patients had severe tracheal stenosis that was exceeding 70%. Their preferred treatment options were Nd: YAG laser incision and either mechanical or balloon dilatation under rigid bronchoscopy.

Stenotic lesions which are appropriate for endoscopic treatment have some key features: (a) the presence of an external cartilaginous support (b) short (less than 1 cm) vertical stenotic length (for endoscopic stenting less than < 3 cm is preferable), (c) noncircumferential stenosis, and (d) strictly tracheal localization (16). Moreover, endoscopic procedures can be used as a first line option up to definitive surgical intervention in patients who had simple stenosis. Recent developments in the field of interventional pulmonology led minimally invasive endoscopic approaches more popular in the management of PITS (17,18). Mostly used endoscopic interventions are mechanical or balloon dilation, laser incision, cryoextraction, electrocautery, photodynamic therapy, stenting, and local applications of mitomycin C, 5-fluorouracil, and steroids. Although rigid bronchoscopic techniques are commonly preferred for endotracheal intervention, flexible bronchoscopy can also be used instead of rigid ones for intubation, dilatation, and stenting in patients with tracheal stenosis (19).

However dilation procedures are safe and well-tolerated among patients, it is associated with temporary improvement and often requires repeated dilations or

finally airway surgery. We performed mechanical dilation to 109 patients, but we had to repeat the procedure. The number of rigid bronchoscopy was  $2.6 \pm 2.6$  (range, 1-19) for our patients. To overcome the high recurrence rates of dilatation, more efficient endoscopic techniques are developed. Among them, topical MMC application was approved as a procedure that might improve airway surgery outcomes (20). It is a kind of anthracycline antibiotic that derived from *Streptomyces caespitosus*. MMC is an alkylating agent that inhibits DNA synthesis (21). Smith and Elstad concluded that MMC may extend the time to recurrence in the majority of patients, but does not reduce the risk of recurrence (22). On the other hand, there is data regarding the ineffectivity of MMC in the prevention of tracheal stenosis after rigid bronchoscopic dilatation in PITS patients (23). In a study conducted by Madan et al. almost all patients experienced recurrence after a single dose of MMC application (0.4 mg/mL). In the English literature, a dose of 0.1-2 mg/mL MMC have been used (24,25). But the scarce data and poor trial quality in human studies makes it difficult to draw exact conclusions. In our study, we applied MMC by using saturated pledgets at 0.5 mg/mL for 2 minutes over each stenosis site to 6 patients, 5 of them cured without any other procedure, 1 of them had tracheal stent application.

There is a wealth of literature supporting the use of tracheal stents in treating benign and malignant tracheal stenosis. Four (13.3%) patients in Elsayed et al's series went on to have tracheal stents after multiple failed dilations (26). The use of metallic stents in malignant stenosis is well established but treatment of benign stenosis using metallic stents is contraindicated. In their study, Martinez-Ballarín et al. reported their data regarding the use of silicone Dumon<sup>®</sup> stents for tracheal stenting in a total of 64 patients who had inflammatory benign tracheal stenosis (14). While the procedure was well-tolerated it was also associated with same complications such as stent migration (17.5%), granulation (6.3%) and airway obstruction due to mucostasis (6.3%). In our case series, tracheal stent insertion applied in 49 (44.5%) of 110 patients. Preferred stent was usually 16 x 14 x 16 silicone tracheal stents. Stent complication after insertion was seen in 22 patients, these were; migration (n= 9, 8.2%), granulation (n= 16, 14.5%), malacia (n= 5,

4.5%), mucostasis (n= 18, 16.4%), and stenosis at the edge of the stent (n= 1, 1%).

The success data of surgery and endoscopic procedures varies in studies. Nouraei et al. reported that surgery was associated with higher success rates than endoscopic options (9). They also concluded that endoscopic treatment failure was associated with older patient age and increasing stenotic length. In their study, Sarper et al. reported 11 patients (among them 85% had mild stenosis) and 34 patients underwent bronchoscopic treatment and open surgery, respectively. For patients who surgical resection the success rate was 96% (27). Ulasan et al. reported no recurrence or complication after open surgery in 15 of 22 (68.2%) patients in long term follow-up (28). Of the remaining 7 patients, two (9.1%) died in the early postoperative period, and five (22.7%) required a stent insertion due to restenosis. Their success rate was 68.2%, and they concluded that the rate might have been influenced by their clinical inexperience. In our series, mortality rate for patients who had surgery was 16.7%, and for patients who had endoscopic procedures was 36.5%.

The most encountered complications of surgery are excessive granulation and restenosis at the anastomosis line, fistula formation, cervicomediastinal sepsis, innominate artery rupture, anastomosis opening, and recurrent laryngeal nerve injury (29). Alvarez-Maldonado et al. reported the incidence of restenosis after surgery 43% (3/7) (30). In our case series, 13 of 36 patients had restenosis after surgery, but we were not able to analyze factors related to its appearance.

The limitations of our study are; 1) It has a retrospective design, 2) Patients number is small in different therapy groups, so we were not able to compare these therapeutic options, 3) We were not able to analyze factors related to restenosis after surgery, 4) We were not able to compare the mortality rates between groups, and the causes of mortality, because of the retrospective design of the study. We could not reach all the information about the patients, and procedures. Future studies, which will investigate the most useful therapeutic option in PITS patients, will be able to add more information to the literature.

In conclusion, PITS/PTTS is an iatrogenic condition due to regional ischemic necrosis of the trachea. The recent developments and improvements in the design

of endotracheal and tracheostomy tubes decreased the incidence of these conditions. However, it remains a major problem and a common indication for open tracheal surgery. Careful assessment of the degree and length of the lesion, presence of comorbidity are important when deciding treatment option.

#### CONFLICT of INTEREST

The authors declare that they have no conflict of interest.

#### AUTHORSHIP CONTRIBUTIONS

Concept/Design: MAÖ

Analysis/Interpretation: GK, DT

Data Acquisition: ŞG, ET, GÖ

Writing: MAÖ

Critical Revision: EÇ, EGUC

Final Approval: All of authors.

#### REFERENCES

1. Lorenz RR. Adult laryngotracheal stenosis: etiology and surgical management. *Curr Opin Otolaryngol Head Neck Surg* 2003;11:230-5.
2. Ahn HY, Su Cho J, Kim YD. Surgical outcomes of post intubational or post tracheostomy tracheal stenosis: report of 18 cases in single institution. *Ann Thorac Cardiovasc Surg* 2015;21:14-7.
3. Pearson FG, Andrews MJ. Detection and management of tracheal stenosis following cuffed tube tracheostomy. *Ann Thorac Surg* 1971;12:359-74.
4. Stauffer JL, Olson DE, Petty TL. Complications and consequences of endotracheal intubation and tracheostomy. A prospective study of 150 critically ill adult patients. *Am J Med* 1981;70:65-76.
5. Myer CM III, O'Connor DM, Cotton RT. Proposed grading system for subglottic stenosis based on endotracheal tube sizes. *Ann Otol Rhinol Laryngol* 1994;103:319-23.
6. Galluccio G, Lucantoni G, Battistoni P, Paone G, Batzella S, Lucifora V, et al. Interventional endoscopy in the management of benign tracheal stenoses: definitive treatment at long-term follow-up. *Eur J Cardiothorac Surg* 2009;35:429-33.
7. Tsakiridis K, Darwiche K, Visouli AN, Zarogoulidis P, Machairiotis N, Christofis C, et al. Management of complex benign post-tracheostomy tracheal stenosis with bronchoscopic insertion of silicon tracheal stents, in patients with failed or contraindicated surgical reconstruction of trachea. *J Thorac Dis* 2012;4:32-40.
8. Marel M, Pekarek Z, Spasova I, Pařko P, Schutzner J, Betka J, et al. Management of benign stenoses of the large airways in the university hospital in Prague, Czech Republic, in 1998-2003. *Respiration* 2005;72:622-8.

9. Nouraei R, Ghufour K, Patel A, Ferguson T, Howard DJ, Sandhu GS. Outcome of endoscopic treatment of adult postintubation tracheal stenosis. *Laryngoscope* 2007;117:1071-9.
10. Wright CD, Grillo HC, Wain JC, Wong DR, Donahue DM, Gaissert HA, et al. Anastomotic complications after tracheal resection: prognostic factors and management. *J Thorac Cardiovasc Surg* 2004;128:731-9.
11. Abbasidezfouli A, Shadmehr MB, Arab M, Javaherzadeh M, Pejhan S, Daneshvar A, et al. Postintubation multisegmental tracheal stenosis: treatment and results. *Ann Thorac Surg* 2007;84:211-4.
12. George M, Lang F, Pasche P, Monnier P. Surgical management of laryngotracheal stenosis in adults. *Eur Arch Otorhinolaryngol* 2005;262:609-15.
13. Marulli G, Rizzardì G, Bortolotti L, Loy M, Breda C, Hamad AM, et al. Single-staged laryngotracheal resection and reconstruction for benign strictures in adults. *Interact Cardiovasc Thorac Surg* 2008;7:227-30.
14. Martínez-Ballarín JJ, Díaz-Jiménez JP, Castro MJ, Moya JA. Silicone stents in the management of benign tracheobronchial stenoses. Tolerance and early results in 63 patients. *Chest* 1996;109:626-9.
15. Zias N, Chroneou A, Tabba MK, Gonzalez AV, Gray AW, Lamb CR, et al. Post tracheostomy and post intubation tracheal stenosis: report of 31 cases and review of the literature. *BMC Pulm Med* 2008;8:18.
16. Simpson GT, Polanyi TG. History of the CO<sub>2</sub> laser in otolaryngology surgery. *Otolaryngol Clin North Am* 1983;16:739-52.
17. Cosano Povedano A, Muñoz Cabrera L, Cosano Povedano FJ, Rubio Sanchez J, Pascual Martínez N, Escribano Duenas A. Endoscopic treatment of central airway stenosis: five years' experience. *Arch Bronconeumol* 2005;41:322-7.
18. Wong JL, Tie ST, Samril B, Lum CL, Rahman MR, Rahman JR. Successful treatment of tracheal stenosis by rigid bronchoscopy and topical mitomycin C: a case report. *Cases J* 2010;3:2.
19. Li WT, Xiao YB, Liu GN, Huang SM, Ling Y, Zhang JQ, et al. Management of benign tracheal stenosis by intubation dilatation under flexible bronchoscopic guidance. *Zhonghua Yi Xue Za Zhi* 2011;91:2995-8.
20. Warner D, Brietzke S. Mitomycin C and airway surgery: how well does it work? *Otolaryngol Head Neck Surg* 2008;138:700-9.
21. Rojas-Solano J, Becker HD. Bronchoscopic application of mitomycin-C as adjuvant treatment for benign airway stenosis. *J Bronchol Interv Pulmonol* 2011;18:53-5.
22. Smith ME, Elstad M. Mitomycin C and the endoscopic treatment of laryngotracheal stenosis: are two applications better than one? *Laryngoscope* 2009;119:272-83.
23. Madan K, Agarwal R, Aggarwal AN, Gupta D. Utility of rigid bronchoscopic dilatation and mitomycin C application in the management of postintubation tracheal stenosis: case series and systematic review of literature. *J Bronchology Interv Pulmonol* 2012;19:304-10.
24. Cosano-Povedano J, Muñoz-Cabrera L, Jurado-Gómez B, Fernández-Marín C, Cobos-Ceballos J, Cosano-Povedano A. Topical mitomycin C for recurrent bronchial stenosis after lung transplantation: a report of 2 cases. *J Bronchol Interv Pulmonol* 2008;15:281-3.
25. Erard AC, Monnier P, Spiliopoulos A, Nicod L. Mitomycin C for control of recurrent bronchial stenosis: a case report. *Chest* 2001;120:2103-5.
26. Elsayed H, Mostafa AM, Soliman S, Shoukry T, El-Nori AA, El-Bawab HY. First-line tracheal resection and primary anastomosis for postintubation tracheal stenosis. *Ann R Coll Surg Engl* 2016;98:425-30.
27. Sarper A, Ayten A, Eser I, Ozbudak Ö, Demircan A. Tracheal stenosis after tracheostomy or intubation: review with special regard to cause and management. *Tex Heart Inst J* 2005;32:154-8.
28. Uluhan A, Sanli M, Isik AF, Celik IA, Tuncozgun B, Elbeyli L. Surgical treatment of postintubation tracheal stenosis: A retrospective 22-patient series from a single center. *Asian J Surg* 2018;41:356-62.
29. Auchincloss HG, Wright CD. Complications after tracheal resection and reconstruction: prevention and treatment. *J Thorac Dis* 2016;8:160-7.
30. Alvarez-Maldonado P, Peña J, Criales-Cortés JL, Navarro-Reynoso F, Pérez-Romo A, Cicero-Sabido R. Benign tracheal stenosis: a case series analysis. *J Bronchology Interv Pulmonol* 2009;16:254-60.